Original article

# Cricoid pressure revisited

**Shyamsunder Kamath,* Sathyajith Karanth, Cherish Paul, Saranya Ramaswami**
Email: shyamsunderkamath@yahoo.co.in

## Abstract

**Background**: Cricoid pressure is used in rapid sequence intubation in patients with full stomach. Intubation may become difficult with adverse consequences with this manoeuvre, as laryngeal view may be altered. We used a cricoid device to standardise the cricoid pressure. **Aim:** To study the effectiveness of cricoid pressure delivered by a mechanical device in occluding the oesophagus (by visual assessment using a fibreoptic bronchoscope) and to assess the quality of laryngeal view after the application of cricoid pressure using a Macintosh laryngoscope. **Patients and methods**: 41 patients of ASA I and II, posted for elective surgery were enrolled in this prospective crossover study. They were randomly allocated to one of two interventions Intervention: A (with cricoid pressure) followed by Intervention B (without cricoid pressure) or intervention B followed by intervention A. Assessment of oesophageal opening and laryngeal grading was done. Assessor was blinded whether cricoid pressure was applied or not (cricoid device was designed to conceal the weight applied). **Results:** Oesophageal opening was occluded in 95% (39/41) of patients, with cricoid pressure and 88% (36/41) patients without cricoid pressure. 51% (21/41) of patients with cricoid pressure had worsening of laryngeal view. Whereas there was no change in 32% (13/41) of patients, there was improvement in 17% (7/41), with cricoid pressure. **Conclusion**: Irrespective of the cricoid pressure administered oesophageal opening appeared occluded in majority of the cases. Cricoid pressure delivered by cricoid device alters the quality of the laryngeal view.

**Keywords** : cricoid, pressure, larynx, device, oesophagus

## Introduction

Cricoid pressure has been described as the 'linchpin of the rapid sequence induction' and has become widely accepted as a standard practice to prevent regurgitation of gastric and oesophageal contents and their subsequent pulmonary aspiration, since its description by Sellick in 1961.[1,2] Improper application can cause distortion of the larynx and trachea, which in turn may create difficult airway scenario and related complications. To ensure cricoid pressure to be safe and effective, instruments have been invented *e.g.*, cricoid yoke.[3,4] Any instrument designed for this purpose should be simple, easy to familiarise, should cause no trauma and should be effective. The aim of this study was to evaluate the effectiveness of cricoid pressure delivered by a mechanical device in occluding the oesophageal opening by visual assessment using a fibreoptic bronchoscope and to assess the quality of laryngeal view after the application of cricoid pressure using a laryngoscope.

**Shyamsunder Kamath,** MD
*Associate Professor of Anaesthesiology, Kasturba Medical College, Manipal – 576 104*

**Sathyajith Karanth,** DA, DNB
*Associate Professor of Anaesthesiology, Srinivas Institute of Medical Sciences and Research, Srinivas Nagar, Mukka, Mangalore – 575 021*

**Cherish Paul,** MD
*Assistant Professor of Anaesthesiology, Kasturba Medical College, Manipal – 576 104*

**Saranya Ramaswami,** MD
*Consultant Anaesthetist, Kurinji Hospital, Coimbatore – 641 028*

**How to cite this article:** Kamath S, Karanth S, Paul C, Ramaswami S. Cricoid pressure revisited. Ind J Resp Care 2012; 1:47-52.

## Patients and methods

The study was designed to be a prospective, crossover study. The study was commenced after obtaining approval from Institutional Ethical Committee. A total of 41 patients were enrolled in this study. Adult patients of either gender, between age 16 to 65 years, belonging to ASA physical status I and II, with body mass index (BMI) < 30 kg/m$^2$, and those posted only for elective surgery under general anaesthesia were enrolled. Patients with known or anticipated difficult airway, upper airway infection, obstruction or pharyngeal pathology, cervical spine problems, cardiovascular disease, intracranial lesions, epilepsy, pulmonary disease, history of allergy to any of the drugs used in the study protocol and patients requiring rapid sequence induction were excluded.

There were 2 observers, observer 1 – One of the three anaesthesiology consultants (Kamath S, Karanth S or Paul C) with at least 5 years of experience and well trained in fibreoptic bronchoscopy and observer 2 - Anaesthesiology resident involved in the study who assessed the patient.

Observer 1 performed following interventions: Intervention A –Assessment of oesophageal opening (whether occluded or not) and laryngeal grading with cricoid pressure and Intervention B – Assessment of oesophageal opening (whether occluded or not) and laryngeal grading without cricoid pressure. He was blinded to the order in which the interventions were performed – Intervention A followed by B or *vice versa* was determined by random pick of lots.

In order to administer a uniform and sustained cricoid pressure throughout the study, a mechanical device was designed and used in this study *(Figure 1)*. Cricoid device designed was made of steel and consisted of the following parts: 1) Plate – Weight is placed on this plate and is covered with a lid, 2) Rod - attached to the base of the plate, which has a screw to adjust the length, 3) Cricoid foam – placed on the cricoid cartilage, 4) Stand – holds plate *via* springs. The plate has a lid to conceal the weight when placed on it so that Observer 1 would be blinded towards intervention A or B. The pressure exerted by the weight is transmitted by the rod to the cricoid foam. The cricoid foam was placed such that it was just in contact with the cricoid cartilage. Thus an effective and sustained pressure was applied on the cricoid cartilage.

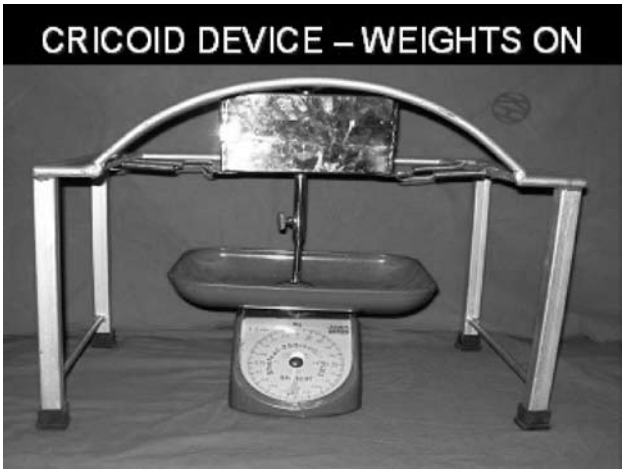


***Figure 1:*** Cricoid device - checking the pressure and calibrating with weights concealed in the box attached to the stand by springs.

The correct amount of force is 20-30 Newtons, which is about 2-3 kilogram weight (10 N = ~ 1 kg weight).[5,6] Weight added to the plate was sufficient enough to produce 2-3 kg weight. The device was calibrated by using a weighing scale and the appropriate weight required to produce 2-3 kg weight was determined. All the patients were assessed preoperatively by observer 2 on the day prior to procedure. Informed consent was obtained from each of the patients. All patients were kept nil per oral, a minimum of 6 h for solids and 3 h for clear liquids prior to surgery. Premedication was given by the concerned anaesthesia team. Before shifting to operating room, 2 drops of oxymetazoline were administered in each nostril. On arrival of patient in the operating room, an intravenous infusion was set up through a cannula inserted into a suitable vein in an upper limb. Intravenous glycopyrrolate 0.2 mg was given. Essential noninvasive monitoring including electrocardiogram (standard lead II and $V_5$), pulse oximetry, capnography and automated noninvasive blood pressure was set up. A peripheral nerve stimulator was attached by cables to two surface electrodes fixed over the surface marking of the ulnar nerve on the anterior aspect of distal forearm. Patient was made to lie supine and a wooden

board of size 60 cm x 40 cm was placed under the patient (head, neck and the scapular areas). The wooden board would act as a steady platform for the '*cricoid device*'. The patient was then positioned in the '*sniffing*' position with head ring placed at the occiput. Patient was preoxygenated for three minutes and anaesthesia was induced as per the concerned anaesthesia team. Once induced, cricoid cartilage was marked as described below. The most prominent protuberance on the front of the neck in the midline (the thyroid prominence) was felt. The finger was dragged towards the patient's feet (staying in the midline) until the drop into the cricothyroid notch or membrane was felt. The next horizontal bar was the cricoid cartilage. After confirming ability to mask ventilate, skeletal muscle paralysis was achieved with intravenous vecuronium 0.12 mg/kg. The peripheral nerve stimulator was set to deliver a current of 40 mA, TOF stimuli at 12 s intervals. Anaesthesia was maintained with 1.5% isoflurane in 100% oxygen with manual ventilation *via* face mask using circle absorber system. Cricoid device was placed on the patient, with or without weights added to the plate by observer 2 in the absence of observer 1, depending on intervention decided by randomisation. After complete neuromuscular blockade was ensured by train of four (TOF) count of 0/4, fibreoptic bronchoscope was introduced through the nasopharynx placing the tip of scope at the level of the epiglottis to view the oesophageal opening. Oesophageal occlusion was assessed by observer 1. After the assessment, the fibreoptic bronchoscope was removed. Direct laryngoscopy *(Figure 2)* was performed by using a short handle laryngoscope and grading of laryngeal view was done by observer 1. Grading was done according to Cook's modification of Cormack and Lehane's grading, *i.e.*, Grade 1: Most of the cords visible, Grade 2a: Posterior part of cords visible, Grade 2b: Only arytenoids visible, Grade 3a: Epiglottis visible and liftable, Grade 3b: Epiglottis adherent to pharynx Grade 4: No laryngeal structures seen.[7] Lateral shift of larynx from midline was also assessed in this study as an additional observation. Oesophageal occlusion and grading of laryngeal view was done for the next intervention in the same patient as a crossover observation. Patients were manually ventilated with 1.5 % isoflurane with 100% oxygen in between the two interventions. If patient desaturated to 92% at any time during the procedure, immediate mask ventilation with 1.5% isoflurane in 100% oxygen was done and another attempt made when the saturation picked up. Maximum of 3 attempts were allowed. If there was any difficulty in visualising the oesophageal opening, jaw lift manoeuvre was performed. If it did not improve the visualisation then the case was excluded from study. Care was taken that there was no trauma caused by the cricoid foam when placed on the cricoid cartilage. The foam was soft and thus did not cause any injury.


***Figure 2:*** Laryngoscopy with cricoid device on

The sample size was determined based on the pilot study done on 20 patients and with power of study as 80%. The study data were analysed using SPSS version 13.0 Windows. McNemars test was used to analyse effect of cricoid pressure on oesophageal opening and laryngeal shift. P value of 0.05 or less was taken as significant.

## Results

A total of 41 patients were enrolled in this study. There were no complications attributable to the study. The arterial oxygen saturation (as measured by the pulse oximeter) did not fall below 99% in any of the patients during the period of observation. None of the patients were excluded from the study due to desaturation or difficulty in visualising the oesophagus.

Assessment of oesophageal opening with the help of fibreoptic bronchoscope with cricoid

pressure and without cricoid pressure is depicted in *Figure 3*. Most of the patients in the study had oesophageal opening occluded even without cricoid pressure.

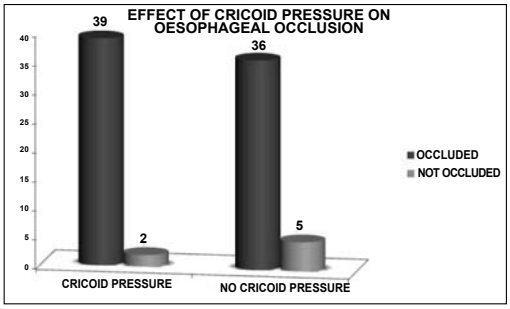


***Figure 3:*** Effect of cricoid pressure on oesophageal occlusion

The laryngoscopic grade with and without cricoid pressure in all patients is depicted in *Table 1*. The effect of cricoid pressure on laryngoscopic grade was unpredictable. Eight patients in all had deteriorated from 2a and 2b grades without cricoid pressure to 3a or 3b grades with cricoid pressure. On the other hand, there were four patients with Grade 3a and 3b view without cricoid pressure who improved to Grade 2a or 2b with cricoid pressure. The changes did not reach statistical significance.

***Table 1:*** Effect of cricoid pressure on laryngeal view (Cook's modification of Cormack and Lehane's grading)

| | | With cricoid pressure | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2a | 2b | 3a | 3b | |
| Without cricoid pressure | 1 | 4 | 6 | 1 | 0 | 0 | 11 |
| | 2a | 0 | 6 | 6 | 7 | 0 | 19 |
| | 2b | 0 | 3 | 3 | 0 | 1 | 7 |
| | 3a | 0 | 0 | 3 | 0 | 0 | 3 |
| | 3b | 0 | 0 | 1 | 0 | 0 | 1 |
| | Total | 4 | 15 | 14 | 7 | 1 | 41 |

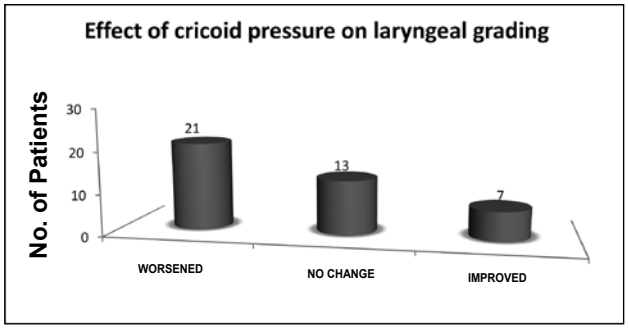


***Figure 4:*** Overall effect of cricoid pressure on laryngeal grading (Cook´s modified laryngoscopy classification)

*Figure 4* shows the overall effect of cricoid pressure on the laryngoscopic grade. While 13 patients had no change in their laryngoscopic grade, 21 patients had worsening of laryngoscopic grade. Only 7 patients had improved laryngeal grade with cricoid pressure.

*Table 2* shows the number of grade changes with the application of cricoid pressure.

***Table 2:*** Change in grade of laryngeal view with application of cricoid pressure.

| Grade change in the laryngeal view with cricoid pressure | No. of patients |
|---|---|
| Worsened by 1 grade | 12 |
| Worsened by 2 grades | 9 |
| No change in grade | 13 |
| Improved by 1 grade | 6 |
| Improved by 2 grades | 1 |

*Figure 5* shows the effect of cricoid pressure on the larynx, shifting it from midline. It was found that 23 patients had laryngeal shift from midline with cricoid pressure and 13 patients had laryngeal shift from midline without cricoid pressure. The shift of larynx was statistically significant.

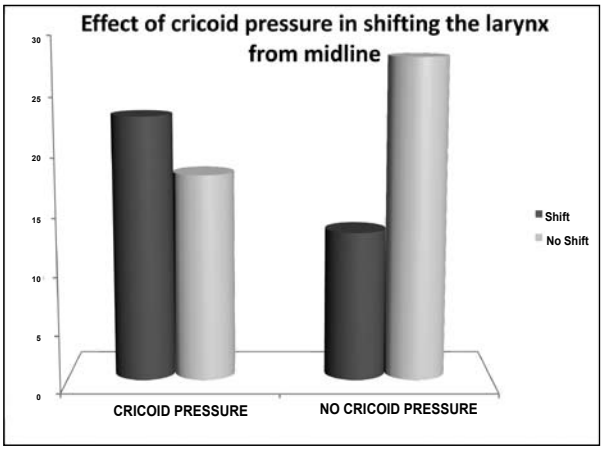


***Figure 5:*** Effect of cricoid pressure in shifting the larynx from midline

## Discussion

The application of cricoid pressure in the patient presenting with a full (or potentially full) stomach is to prevent regurgitation and aspiration. Brimacombe

and Berry in their review article stated that if cricoid pressure is to remain a standard practice during induction of anaesthesia, it must be shown to be safe and effective.[8] Quick, atraumatic intubation of the trachea requires optimal visualisation of the glottis. Successful application of cricoid pressure requires an appropriate externally applied force effectively transmitted through the arch of the cricoid ring to occlude the oesophagus against the fifth cervical vertebral body.[9] Application of cricoid pressure may be the direct or contributory cause in the 'cannot intubate, cannot ventilate' scenario. It is suggested that controlled release of cricoid pressure is advisable if ventilation of the lungs is problematic and it is recommended that the applied cricoid force be 20 to 30 N.[5,8,10] Misapplication may occur with respect to position or force. Force may be excessive or insufficient and if inappropriately applied may lead to anatomical distortion. In clinical practice, Howells and colleagues demonstrated that the force applied by anaesthesia assistants varies widely, resulting in a proportion of patients remaining at risk of regurgitation because of inadequate pressure.[11] Studies have shown improvement in the application of cricoid force after simple training programmes for up to 3 weeks.[12] Devices have been described which allow the exact force to be applied but manual application still remains the commonest method.[5,9] However, this technique and its application remain highly unpredictable and is a subjective exercise.

We decided to use a mechanical device, indigenously designed, which when used during the accelerated induction technique, would deliver a consistent and adequate cricoid pressure.

The device was designed to be simple to use and easy to familiarise as described in the methodology. Effectiveness of the device in occluding the oesophageal opening was visually assessed with the help of fibreoptic bronchoscope. A similar study was done by Palmer and Ball, in which cricoid pressure was applied with cricoid yoke and the effect on the cricoid cartilage and vocal cords were assessed with the help of fibreoptic bronchoscope through a laryngeal mask airway.[13] They assessed the effect of 20N, 30N and 44N on the internal appearance of the cricoid cartilage and vocal cords. At 44N, cricoid deformation occurred in 27/30 patients (90%) and 15/30 (50%) had cricoid occlusion. At 30N 13/30 patients (43%) had cricoid occlusion and 7/30 (23%) at 20N. In the current study the force applied by the device was between 20-30 N (around 2.6 kg weight). Several studies regarding the correct amount of cricoid pressure have been done. According to an article cited in the Journal of Emergency Primary Health Care on effective use of cricoid pressure; the correct amount of pressure is 20-30 N ( 2-3 kg weight).[6] In our study, it was ensured that the cricoid foam when placed on the cricoid cartilage was just in contact with it prior to the adding of weight. It was soft enough to cause no trauma. Studies have mentioned that cricoid yoke had caused cricoid cartilage deformation.[13] Not many studies are available where oesophageal occlusion was assessed visually. Wraight WJ *et al* have studied oesophageal pressure with the application of cricoid pressure.[14]

Conventionally, Cormack and Lehane's classification is used to assess the view of the larynx.[15] Cook demonstrated that a new classification is as sensitive and more specific in predicting difficult intubation.[7]

In a study done by Vanner *et al* , comparing the view at laryngoscopy with and without the application of cricoid pressure, and standard cricoid pressure (as described by Sellick) with that of cricoid pressure applied in upward and backward direction (with the thumb and the forefinger on either side of the cartilage), they found that cricoid pressure is likely to improve the laryngoscopic view which may be further improved by applying it in an upward and backward direction.[16]

Few limitations in this study are visual assessment of the oesophageal opening did not confirm the effectiveness of cricoid pressure. Measurement of the oesophageal pressure with the administration of cricoid pressure would be an effective method to confirm occlusion of oesophageal opening. Vanner and colleagues studied upper oesophageal sphincter pressure and effect of cricoid pressure.[17] In this the upper oesophageal sphincter pressure was measured during the administration of cricoid pressure.

Another limitation of this study is the small sample size. A larger sample size would have enabled intergroup analysis of the laryngeal grade changes with cricoid pressure.

## Conclusion

Irrespective of the cricoid pressure administered, oesophageal opening appeared occluded in majority of the cases. Cricoid pressure delivered by cricoid device alters the quality of the laryngeal view.

## References


1. Sellick BA. Cricoid pressure to control regurgitation of stomach contents during induction of anaesthesia. *Lancet* 1961; **2**:404–6.
2. Salem MR, Sellick BA, Elam JO. The historical background of cricoid pressure in anesthesia and resuscitation. *Anesth Analg* 1974; **53**:230–2.
3. Lawes EG. Cricoid pressure with or without the "cricoid yoke". *Br J Anaesth* 1986; **58**:1376–9.
4. Lawes EG, Duncan PW, Bland B, Gemmel L, Downing JW. The cricoid yoke - a device for providing consistent and reproducible cricoid pressure. *Br J Anaesth* 1986; **58**:925–31.
5. Vanner RG, Asai T. Safe use of cricoid pressure. *Anaesthesia* 1999;**54**:1–3.
6. Hein C, Owen H. The effective application of cricoid pressure. *J Emerg Pry Health Care* (JEPHC), 2005; **3**:1–2.
7. Cook TM. A grading system for direct laryngoscopy. *Anaesthesia* 1999; **54**:496–7.
8. Brimacombe JR, Berry AM. Cricoid pressure. *Can J Anaesth* 1997; **44**:414–25.
9. Crowley DS, Giesecke AH. Bimanual cricoid pressure. *Anaesthesia* 1990; **45**:588–9.
10. Vanner RG, O'Dwyer JP, Pryle BJ, Reynolds F. Upper oesophageal sphincter pressure and the effect of cricoid pressure. *Anaesthesia* 1992; **47**: 95–100.
11. Howells TH, Chamney AR, Wraight WJ, Simons RS. The application of cricoid pressure. An assessment and a survey of its practice. *Anaesthesia* 1983; **38**:457–60.
12. Ashurst N, Rout CC, Rocke DA, Gouws E. Use of a mechanical simulator for training in applying cricoid pressure. *Br J Anaesth* 1996; **77**:468–72.
13. Palmer JHM, Ball DR. The effect of cricoid pressure on the cricoid cartilage and vocal cords: an endoscopic study in anaesthetised patients. *Anaesthesia* 2000; **55**:263–8.
14. Wraight WJ, Chamney AR, Howells TH. The determination of an effective cricoid pressure. *Anaesthesia* 1983; **38**:461–6.
15. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. *Anaesthesia* 1984; **39**:1105–11.
16. Vanner RG, Clarke P, Moore WJ, Raftery S. The effect of cricoid pressure and neck support on the view at laryngoscopy. *Anaesthesia* 1997; **52**: 896–900.
17. Vanner RG, O'Dwyer JP, Pryle BJ, Reynolds F. Upper oesophageal sphincter pressure and the effect of cricoid pressure. *Anaesthesia* 1992; **47**: 95–100.